M. Grandidier gains the Savigny prize for researches on the fauna of Zanzibar and Madagascar; while the Thorel prize is awarded both to M. Vayssières and M. Joly, for observations proving a small animal found in streams to be the larva of an insect of the family of Ephemerans.

The Montyon prize for statistics goes to Dr. Ricoux for his "Figured Demography of Algeria."

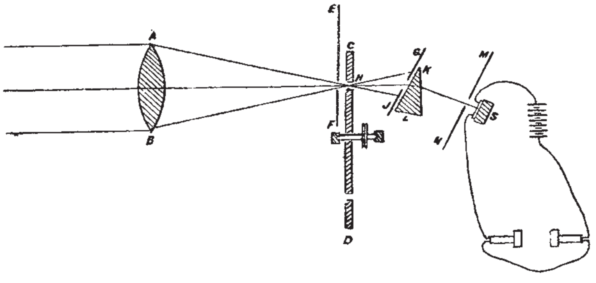
We further note that M. Birckel receives 1500 francs on the Montyon foundation, for an improvement in the Davy lamp, and that M. Dupuis receives the Delaland-Guerineau prize for his explorations in Tonkin.

The published list of subjects for prize competition in 1881, 1882, 1883, and 1885 comprises the following subjects (briefly stated) among others:—Motor for tramways; physiology of champignons; influence of environment on plant-organs; structure and development of cork; internal organisation of European edriophthalmate crustaceans; cure of Asiatic cholera; genito-urinary organs; revision of the theory of Jupiter's satellites; elasticity of crystalline bodies; origin of atmospheric electricity, and causes of electric phenomena in thunderstorms; inoculation as a prophylactic for domestic animals; coloured parts of the tegumentary system of animals, and fecundating matter of animated beings; marine, lacustrine, and terrestrial deposits on the French coast since the Roman epoch; botany of the North of France; diagnostic signs of death and prevention of premature burial.

MEASURING THE INDEX OF REFRACTION OF EBONITE[1]

PROF. BELL found that when an intermittent beam of light fell on a sensitive selenium cell the sound produced in a telephone (which with a battery was attached to the selenium) was not entirely destroyed by interposing a thin sheet of ebonite in the path of the intermittent rays of light, or, in other words, that ebonite was slightly transparent for invisible rays that affected selenium. It occurred to us some months ago that if such invisible rays were at all of the nature of light, they probably suffered retardation in passing through the ebonite, or that refraction would take place if the sheet of ebonite were replaced by an ebonite prism or lens, a result we have been able experimentally to confirm, and at the same time to measure the index of refraction.

A B is a glass lens concentrating a parallel beam coming from a lime-light on to one hole H in a rapidly revolving brass disk C D. This disk we have constructed many times as thick as the one employed by Prof. Bell, and have thus succeeded in eliminating all the sound produced by the syren action of the disk, so disturbing in delicate experiments. E F is a stationary zinc screen with a hole in it smaller than the holes in the rotating disk.



1. We first tried to focus these intermittent rays on a selenium cell by means of an *ebonite* lens, and so determine the focal length of the lens; but as our lens was then not mounted on an optical bench, so as to be moved parallel to itself, or rotated through known angles, and as the rays were invisible, so that our eyes could not of course guide us as to the proper position in which to put the lens, we failed to succeed in this very delicate experiment, which however our subsequent experiments, now to be described, show must ultimately succeed with the lens properly mounted.

2. A small portion of the intermittent light which passed through the hole H in the rotatory disk was allowed to fall on an ebonite prism K L, by passing through a slit in a zinc screen G J, the slit being arranged parallel to the edge of the ebonite prism. The prism employed had an angle of 27°·5. M N is another zinc screen with a slit in it also parallel to the edge of the prism, and placed in front of a sensitive selenium cell S (the cell described by us in the account of our experiments on "Seeing by Electricity"). This screen M N was moved parallel to itself, while an experimenter listened with a telephone to each ear, and who was placed in another room, so as not to be influenced by seeing what changes were being made in the position of the screen or in the position of the ebonite prism. The telephones had each a resistance of 74 ohms, and the battery an electromotive force of about 40 volts. No direct light falling on the selenium, the listener at the telephones heard nothing for the majority of positions of the screen M N, but in one position represented in the figure a faint distant sound was distinctly heard, which was entirely cut off by interposing the hand in front of the selenium, or by moving away the prism.

The invisible rays that affect selenium after passing through ebonite are consequently refracted, and some preliminary experiments, when the ebonite prism was arranged for minimum deviation, gave 1·7 as a first rough approximation for the index of refraction of these rays by ebonite. It is interesting to notice that the square, 2·89, of this index of refraction is between the highest and lowest limits obtained by different experimenters for the specific inductive capacity of ebonite, so far agreeing with Maxwell's electromagnetic theory of light.

We are now having prisms of ebonite and of other opaque substances of different angles mounted on a goniometer stand, to enable us to measure the indices of refraction accurately.

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[1] Note communicated to the Royal Society by Professors Ayrton and Perry.

MOLECULAR ELECTROMAGNETIC INDUCTION[1]

THE induction-currents balance which I had the honour of bringing before the notice of the Royal Society (*Proc.* Roy. Soc. vol. xxix. p. 56) showed how extremely sensitive it was to the slightest molecular change in the composition of any metal or alloy, and it gave strong evidence of a peculiarity in iron and steel which its magnetic properties alone failed to account for. We could with all non-magnetic metals easily obtain a perfect balance of force by an equivalent piece of the same metal, but in the case of iron, steel, and nickel it was with extreme difficulty that I could obtain a near approach to a perfect zero. Two pieces of iron cut off the same bar or wire, possessing the same magnetic moment, never gave identical results; the difficulty consisted, that notwithstanding each bar or wire could be easily made to produce the same inductive reaction, the time during which this reaction took place varied in each bar; and although I could easily change its balancing power as regards inductive force by a change in the mass of the metal, by heat or magnetism, the zero obtained was never equal to that obtained from copper or silver.

This led me to suppose the existence of a peculiarity in magnetic metals which could not be accounted for except upon the hypothesis that there was a cause, then unknown, to produce the invariable effect.

Finding that it would be impossible to arrive at the true cause without some new method of investigation, which should allow me to observe the effects from an electrical circuit, whose active portion should be the iron wire itself, I constructed an apparatus or electro-magnetic induction balance, consisting of a single coil reacting upon an iron wire in its axis, and perpendicular to the coil itself; by this means the iron or other wire itself became a primary or secondary, according as the current passed through the coil or wire. Now with this apparatus we could induce secondary currents upon the wire or coil, if the coil was at any angle, except when the wire was absolutely perpendicular; in this state we could only obtain a current from some disturbing cause, and the current so obtained was no longer secondary but tertiary.

The whole apparatus however is more complicated than the general idea given above, as it was requisite not only to produce effects, but to be able to appreciate the direction of the electrical current obtained, and have comparative measures of their value. In order to fully understand the mode of experiments, as well as the results obtained, I will first describe the apparatus employed.

The electro-magnetic induction balance consists—(1) of an instrument for producing the new induction-current; (2) sonometer or balancing coils; (3) rheotome and battery; (4) telephone.

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[1] Paper read at the Royal Society, March 17, by Prof. D. E. Hughes, F.R.S.

The essential portion of this new balance is that wherein a coil is so arranged that a wire of iron or copper can pass freely through and forming its axis, the iron or copper wire rests upon two supports 20 centims. apart; at one of these the wire is firmly clamped by two binding screws; the opposite end of the wire turns freely on its support, the wire being 22 centims. long, having 2 centims. projection beyond its support, in order to fasten upon it a key or arm which shall serve as a pointer upon a circle giving the degrees of torsion which the wire receives from turning this pointer. A binding screw allows us to fasten the pointer at any degree, and thus preserve the required stress the time required.

The exterior diameter of the coil is 5½ centims., having an interior vacant circular space of 3½ centims., its width is 2 centims.; upon this is wound 200 metres of No. 32 silk-covered copper wire. This coil is fastened to a small board so arranged that it can be turned through any desired angle in relation to the iron wire which passes through its centre, and it can also be moved to any portion of the 20 centims. of wire, in order that different portions of the same wire may be tested for a similar stress.

The whole of this instrument, as far as possible, should be constructed of wood, in order to avoid all disturbing inductive influences of the coil.

The iron wire at its fixed end is joined or makes contact with a copper wire, which returns to the front part of the dial under its board and parallel to its coil, thus forming a loop, the free end of the iron wire is joined to one pole of the battery, the copper wire under the board is joined to the rheotome and thence to the battery.

The coil is joined to the telephone; but, as in every instance we can either pass the battery through the wire, listening to its inductive effects upon the wire, or the reverse of this, I prefer, generally, in order to have no voltaic current passing through the wire, to join the iron wire and its loop direct to the telephone, passing the voltaic current through the coil.

In order to balance, measure, and know the direction of the new induction currents by means of a switching key, the sonometer (*Proc.* Roy. Soc., vol. xxix. p. 65) I described to the Royal Society is brought into the circuit. The two exterior coils of the sonometer are then in the circuit of the battery, and of the coil upon the board containing the iron wire or stress bridge. The interior or movable coil of the sonometer is then in the circuit of the iron wire and telephone. Instead of the sonometer constructed as described in my paper to the Royal Society, I prefer to use one formed upon a principle I described in *Comptes rendus*, December 30, 1878. This consists of two coils only, one of which is smaller and turns freely in the centre of the outside coil. The exterior coil being stationary, the centre coil turns upon an axle by means of a long (20 centims.) arm or pointer, the point of which moves over a graduated arc or circle. Whenever the axis of the interior coil is perpendicular to the exterior coil no induction takes place, and we have a perfect zero; by turning the interior coil through any degree we have a current proportional to this angle, and in the direction in which it is turned. As this instrument obeys all the well-known laws for galvanometers, the readings and evaluations are easy and rapid.

If the coil upon the stress bridge is perpendicular to the iron wire, and if the sonometer coil is at zero, no currents or sounds in the telephone will be perceived, but the slightest current in the iron wire produced by torsion will at once be heard; and by moving the sonometer coil in a direction corresponding to the current, a new zero will be obtained, which will not only balance the force of the new current, but indicate its value. A perfect zero however will not be obtained with the powerful currents obtained by the torsion of 2 millims. diameter iron wire; we then require special arrangements of the sonometer, which are too complicated to describe here.

The rheotome is a clockwork having a rapid revolving wheel which gives interruptions of currents in fixed cadences in order to have equal intervals of sound and silence. I employ four bichromate cells or eight Daniell's elements, and they are joined through this rheotome to the coil on the stress bridge, as I have already described.

The magnetic properties of iron, steel, nickel, and cobalt have been so searchingly investigated by ancient as well as by modern scientific authors, that there seems little left to be known as regards its molar magnetism. I use the word molar here simply to distinguish or separate the idea of a magnetic bar of iron or steel magnetised longitudinally or transversely from the polarised molecules which are supposed to produce its external magnetic effects.

Molar magnetism, whilst having the power of inducing an electric current in an adjacent wire, provided that either has motion or a change in its magnetic force, as shown by Faraday in 1832, has no power of inducing an electric current upon itself or its own molar constituent, either by motion or change of its magnetic moment. Molecular magnetism (the results of which I believe I have been the first to obtain) has no, or a very feeble, power of inducing either magnetism or an electric current in an adjacent wire, but it possesses the remarkable power of strongly reacting upon its own molar wire, inducing (comparatively with its length) powerful electric currents, in a circuit of which this forms a part.

We may have also both cases existing in the same wire; this occurs when the wire is under the influence of stress, either external or internal; it would have been most difficult to separate these two, as it was in my experiments with the induction balance without the aid of my new method.

Ampère's theory supposes a molecular magnetism or polarity, and that molar magnetism would be produced when the molecular magnetism became symmetrical; and his theory I believe is fully capable of explaining the effects I have obtained, if we admit that we can rotate the paths of the polarised molecules by an elastic torsion.

Matteucci made use of an inducing and secondary coil in the year 1847 (*Compt. rend.* t. xxiv. p. 301, 1847), by means of which he observed that mechanical strains increased or decreased the magnetism of a bar inside this coil.

Wertheim published in the *Comptes rendus*, 1852 (*Compt. rend.* t. xxv. p. 702, 1852), some results similar to Matteucci; but in the *Annales de Chimie et de Physique*, 1857 (*Ann. de Chim. et de Phys.* (3) t. l. p. 385, 3857), he published a long series of most remarkable experiments, in which he clearly proves the influence of torsion upon the increment or decrement of a magnetical wire.

Vilari showed (*Poggendorff's Annalen*, 1868) increase or diminution of magnetism by longitudinal pull according as the magnetising force is less or greater than a certain critical value.

Wiedermann (Wiedermann's "Galvanismus," p. 447), in his remarkable work, "Galvanismus," says that an iron wire through which an electric current is flowing becomes magnetised by twisting the wire. This I have repeated, but found the effects very weak, no doubt due to the weak battery I use, viz. four quart bichromate cells.

Sir W. Thomson shows clearly in his remarkable contribution to the *Phil. Trans.* Roy. Soc., entitled "Effects of Stress on the Magnetisation of Iron, Nickel, and Cobalt" (*Phil. Trans.* May 6, 1878), the critical value of the magnetisation of these metals under varying stress, and also explains the longitudinal magnetism produced by Wiedermann as due to the outside molar twist of the wire, making the current pass as in a spiral round a fixed centre. Sir William Thomson also shows clearly the effects of longitudinal as well as transversal strains, both as regards its molar magnetism and its electric conductivity.

My own researches convince me that we have in molecular magnetism a distinct and separate form of magnetism from that when we develop, or render evident, longitudinal or transversal magnetism, which I have before defined as molar.

Molecular magnetism is developed by any slight strain or twist other than longitudinal, and it is only developed by an elastic twist; for however much we may twist a wire, provided that its fibres are not separated, we shall only have the result due to the reaction of its remaining elasticity.

If we place an iron wire, say 20 centims. long, 1 millim. diameter, in the axis of the coil of the electro-magnetic balance, and if this wire is joined, as described, to the telephone, we find that on passing an electric current through the inducing coil no current is perceptible upon the iron wire; but if we give a very slight twist to this wire at its free end—one-eighteenth of a turn, or 20°—we at once hear, clear and comparatively loud, the currents passing the coil; and although we only gave a slight elastic twist of 20° of a whole turn, and this spread over 20 centims. in length, making an extremely slight molar spiral; yet the effects are more powerful than if, using a wire free from stress, we turned the whole coil 40°. The current obtained when we turn the coil, as just mentioned, is secondary, and with the coil at any angle any current produced by its action, either on a copper, silver, iron, or steel wire; in fact it is simply Faraday's discovery, but the current from an elastic twist is no longer secondary under the same conditions, but tertiary, as I shall demonstrate later on. The current passing through the coil cannot induce a current upon a wire perpendicular to itself, but the molecules of the outside of the wire, being under a greater elastic stress than the wire itself, they are no longer perpendicular to the centre of the wire, and consequently they react upon this wire as separate magnets would upon an adjacent wire. It might here be readily supposed that a wire having several twists, so a fixed molar twist of a given amount would produce similar effects. It however does not, for in most cases the current obtained from the molar twists are in a contrary direction to that of the elastic torsion. Thus, if I place an iron wire under a right-handed elastic twist of 20° I find a positive current of 50° sonometer; but if I continue this twist so that the index makes one or several entire revolutions, thus giving a permanent molar twist of several turns, I find upon leaving the index free from any elastic torsion, that I have a permanent current of 10°, but it is no longer positive but negative, requiring that we should give an elastic torsion in the previous direction, in order to produce a positive current. Here a permanent elastic torsion of the molecules is set up in the contrary direction to its molar twist, and we have a negative current, overpowering any positive current which should have been due to the twisted wire.

The following table shows the influence of a permanent twist, and that the current obtained when the wire was freed from its elastic torsion was in opposition to that which should have been produced by the permanent twist. Thus a well-softened iron wire 1 millim. in diameter, giving 60° positive current for a right hanled elastic torsion of 20°, gave after 1°·80 permanent torsion a negative current of 10°.

1	complete permanent	torsion (right-handed)	negative ...	10
2	,,	,,	,, ...	15
3	,,	,,	,, ...	15
4	,,	,,	,, ...	16
5	,,	,,	,, ...	12
6	,,	,,	,, ...	10
7	,,	,,	,, ...	5
8	,,	,,	,, ...	4
9	,,	,,	,, ...	3
10	,,	,,	,, ...	3

At this point the fibres of a soft wire commence to separate, and we have no longer a complete single wire, but a helix of separate wires upon a central structure.

If now, instead of passing the current through the coil, I pass it through the wire, and place the telephone upon the coil circuit, I find that I obtain equally as strong tertiary currents upon the coil as in the previous case, although in the first case there was produced longitudinal electro-magnetism in the perpendicular wire by the action of the coil, but in the latter case none or the most feeble electro-magnetism was produced, yet in these two distinct cases we have a powerful current produced not only upon its own wire, but upon the coil, thus proving that the effects are equally produced both on the wire and coil.

If we desire, however, in these reversible effects to produce in both cases the same electromotive force, we must remember that the tertiary current when reacting upon its own short wire produces a current of great quantity, the coil one of comparative higher intensity. We can, however, easily convert the great quantity of the wire into one of higher tension by passing it through the primary of a small induction coil whose resistance is not greater than one ohm. We can join our telephone, which may be then one of a high resistance, to the secondary of this induction coil, and by this means, and without changing the resistance of the telephone, receive the same amount of force, either from the iron wire or the coil.

Finding that iron, steel, and all magnetic metals produce a current by a slight twist, if now we replace this wire by one of copper or non-magnetic metals we have no current whatever by an elastic twist, and no effects, except when the wire itself is twisted spirally in helix; and whatever current we may obtain from copper, &c., no matter if from its being in spiral or from not being perpendicular to the axis of the coils, the currents obtained will be invariably secondary and not tertiary. If we replace the copper by an iron wire, and give it a certain fixed torsion, not passing its limit of elasticity, we find that no increase or decrease takes place by long action or time of being under strain. Thus a wire which gave a sonometric force of 50° at the first observation remained perfectly constant for several days until it was again brought to zero by taking off the strain it had received. Thus we may consider that as long as the wire preserves its elasticity, exactly in the same ratio will it preserve the molecular character of its magnetism.

It is not necessary to use a wire to produce these effects; still more powerful currents are generated in bars, ribbons, or sheets of iron; thus no matter what external form it may possess, it still produces all the effects I have described.

It requires a great many permanent twists in a wire to be able to see any effect from these twists, but if we give to a wire, 1 millim. diameter, forty whole turns (or until its fibres become separated) we find some new effects; we find a small current of 10° in the same direction as its molar twist, and on giving a slight twist (20°) the sonometric value of the sound obtained is 80° instead of 50°, the real value of a similar untwisted wire; but its explanation will be found by twisting the wire in a contrary direction to its molar twist. We can now approach the zero but never produce a current in the contrary direction, owing to the fact that by the spiral direction, due to the fibrous molar turns, the neutral position of its molecule is no longer parallel with its wire, but parallel with its molar twist, consequently an elastic strain in the latter case can only bring the molecules parallel with its wire, producing no current, and in the first case the angle at which the reaction takes place is greater than before, consequently the increased value of its current.

The measurements of electric force mentioned in this paper are all sonometric on an arbitrary scale. Their absolute value has not yet been obtained, as we do not, at our present stage, require any except comparative measures.[1] Thus, if each wire is of 1 millim. diameter and 20 centims. long, all render the same stress in the axis of its coil. I find that the following are the sonometric degrees of value:—

	°		
Soft iron	60	Tertiary	current.
Hard drawn iron...	50	,,	,,
Soft steel	45	,,	,,
Hard tempered steel	10	,,	,,
Copper, silver, &c.	−0	,,	,,
Copper helix, 1 centim. diameter, 20 turns in 20 centims.	45	Secondary	currents.
Iron, spiral, ditto	45	,,	,,
Steel	45	,,	,,

The tertiary current increases with the diameter of the wire, the ratio of which has not yet been determined; thus an ordinary hard iron wire of 1 millim. diameter giving 50°, one of 2 millims. diameter gave 100°; and the maximum of force obtained by any degree of torsion is at or near its limit of elasticity, as if in the same time we also pass this point, producing a permanent twist, the current decreases, as I have already shown in the case of a permanent twist. Thus, the critical point of 1 millim. hard iron wire was 20° of torsion, but in hard steel it was 45°.

Longitudinal strains do not produce any current whatever, but a very slight twist to a wire, under a longitudinal strain, produces its maximum effects: thus, 20° of torsion being the critical point of iron wire, the same wire, under longitudinal strain, required but from 10° to 15°. It is very difficult however to produce a perfect longitudinal strain alone. I have therefore only been able to try the effect of longitudinal strain on fine wires, not larger than 1 millim in diameter, but as in all cases no effect whatever was produced by longitudinal strain alone, I believe none will be found if absolutely free from torsion. The molecules in a longitudinal strain are equally under an elastic strain as in torsion, but the path of their motion is now parallel with its wire, or the zero of electric inductive effect, but the compound strain composed of longitudinal and transverse, react upon each other, producing the increased effect due to the compound strain.

The sonometer is not only useful for showing the direction of the current and measuring it by the zero method, but it als shows at once if the current measured is secondary or tertiary If the current is secondary its period of action coincides with that of the sonometer, and a perfect balance, or zero of sound. is at once obtained, and its value in sonometric degrees given, but if the current is tertiary, no zero is possible, and if the valu of the tertiary is 60°, we find 60° the nearest approach to zer possible. But by the aid of separate induction coils to convert the secondary into a tertiary, a perfect zero can be obtained if the time of action and its force correspond to that which we wish to measure.

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[1] 50° sonometer has the same electromotive force as 0°·10 of a Daniell battery.

If I place a copper wire in the balance and turn the coils at an angle of 45°, I obtain a current which can be perfectly balanced by the sonometer at 50°, proving, as already said, that it is secondary. If I now replace the copper by an iron wire, the coil remaining at 45°, I have again exactly the same value for the iron as copper, viz., 50°, and in both cases secondary. Now, it is evident that in the case of the iron wire there was produced at each passage of the current a strong electro-magnet, but this longitudinal magnetism did not either change the character of the current or its value in force.

A most beautiful demonstration of the fact that longitudinal magnetism produces no current, but that molecular magnetism can act equally as well, no matter the direction of the longitudinal magnetism, consists in forming an iron wire in a loop, or taking two parallel but separate wires, joined electrically at their fixed ends, the free ends being each connected with the circuit, so that the current generated must pass up one wire and down the adjacent one. On testing this loop, and if there are no internal strains, complete silence or absence of current will be found. Now, giving a slight torsion to one of these wires in a given direction, we find, say 50° positive; twisting the parallel wire in a similar direction produces a perfect zero, thus, the current of the second must have balanced the positive of the first. If, instead of twisting it in similar directions, we twist it in the contrary direction, the sounds are increased in value from 50° positive to 100° positive, showing, in this latter case, not only a twofold increase of force, but that the currents in the iron wires travelled up one wire and down the other, notwithstanding that both were strongly magnetic by the influence of the coil in one direction, and this experiment also proves that its molar magnetism had no effect, as the currents are equally strong in both directions, and both wires can double or efface the currents produced in each. If instead of two wires we take four, we can produce a zero, or a current of 200°, and with twenty wires we have a force of 1000°, or an electromotive force of two volts. We have here a means of multiplying the effects by giving an elastic torsion to each separate wire, and joining them electrically in tension. If loops are formed of one iron and one copper wire, we can obtain both currents from the iron wire, positive and negative, but none from the copper, its *rôle* is simply that of a conductor upon which torsion has no effect.

I have already mentioned that internal strains will give out tertiary currents without any external elastic strain being put on. In the case of iron wire these disappear by a few twists in both directions, but in flat bars or forged iron they are more permanent; evidently portions of these bars have an elastic strain, whilst other portions are free, for I find a difference at every inch tested: the instrument however is so admirably sensitive and able to point out not only the strain but its direction, that I have no doubt its application to large forged pieces, such as shafts or cannon, would bring out most interesting results, besides its practical utility; great care is therefore necessary in these experiments that we have a wire free from internal strains, or that we know their value.

Magnetising the iron wire by a large steel permanent magnet has no effect whatever. A hard steel wire thus placed becomes strongly magnetic, but no current is generated, nor has it any influence upon the results obtained from molecular movement, as in elastic torsion. A flat wide iron or steel bar shows this better than iron wire, as we can here produce transversal instead of longitudinal, but neither shows any trace of the currents produced by molecular magnetism. I have made many experiments with wires and bars thus magnetised, but as the effect in every case was negative when freed from experimental errors, I will not mention them; but there is one very interesting proof which the instrument gives, that longitudinal magnetism first passes through its molecular condition before and during the discharge or recomposition of its magnetism. For this purpose, using no battery, I join the rheotome and telephone to the coil, the wire having no exterior circuit. If I strongly magnetise the two ends of the wire, I find by rapidly moving the coil that there is a Faradaic induction of 50° at both poles, but very little or none at the centre of the wire; now fixing the coil at the central or neutral point of the wire and listening intently, no sounds are heard, but the instant I give a slight elastic torsion to the free pole, a rush of electric tertiary induction is heard, whose value is 40°. Again, testing this wire by moving the coil, I find only a remaining magnetism of 10, and upon repeating the experiment of elastic torsion I find a tertiary of 5; thus we can go on gradually discharging the wire, but its discharge will be found to be a recomposition, and that it first passed through the stage I have mentioned.

Heat has a very great effect upon molecular magnetic effects. On iron it increases the current, but in steel the current is diminished. For experimenting on iron wire, which gave a tertiary current of 50° positive (with a torsion of 20°), upon the application of the flame of a spirit-lamp the force rapidly increases (care being taken not to approach red-heat) until the force is doubled, or 100 positive. The same effects were obtained in either direction, and were not due to a molar twist or thermo-current, as if care had been taken to put on not more than 10° of torsion, the wire came back to zero at once on removal of the torson. Hard tempered steel, whose value was 10° whilst cold, with a torsion of 45°, become only 1° when heated, but returned (if not too much heated) to 8° when cold. I very much doubted this experiment at first, but on repeating the experiment with steel several times I found that on heating it I had softened the extreme hard (yellow) temper to that of the well-known blue temper. Now at blue temper, hot, the value of steel was but 1° to 2°, whilst soft iron of a similar size gave 50° of force cold, and 100° at red heat. Now as I have already shown that the effects I have described depend on molecular elasticity, it proves at least, as far as iron and steel are concerned, that a comparatively perfect elastic body, such as tempered steel, has but slight molecular elasticity, and that heat reduces it, but that soft iron, having but little molar elasticity, has a molecular elasticity of a very high degree, which is increased by heat.

The objects of the present paper being to bring the experimental facts before the notice of the Royal Society, and not to give a theoretical solution of the phenomena, I will simply add that if we assume with Poisson that the paths of the molecules of iron are circles, and that they become ellipses by compression or strain, and also that they are capable of being polarised, it would sufficiently explain the new effects.

Joule has shown that an iron bar is longer and narrower during magnetisation than before, and in the case of the transverse strain the exterior portions of the wire are under a far greater strain than those near the centre, and as the polarised ellipses are at an angle with the molecules of the central portions of the wire, its polarisation reacts upon them, producing the comparatively strong electric currents I have described.

SCIENTIFIC SERIALS

Transactions and Proceedings of the Botanical Society of Edinburgh, vol. xiv., part 1, 1881, contains—Address by the president, Dr. T. A. G. Balfour (this address gave brief obituary of J. M'Nab, Sir W. C. Trevelyan, Dr. M. Bain, Prof. Grisebach, A. Forbes, A. J. Adie, Dr. J. Cumming, Karl Koch, Dr. J. Murchison, Dr. D. Moore, P. S. Robertson, Wm. Mudd, Dr. J. F. Th. Inmisch, S. Hay, Dr. M. A. E. Wilkinson, Rev. W. B. Cunningham, E. V. Sandilands, and A. Graham).—Dr. W. Traill, on the growth of *Phormium tenax* in the Orkney Islands.—Wm. Gorrie, on the hardiness of New Zealand plants (1878-79).—Prof. G. Lawson, on British-American species of Viola.—S. Grieve, flora of Colonsay and Oransay.—Jas. Blaikie, botanical tour in Engadine.—Sir R. Christison, on the measurement of trees.—Prof. J. H. Balfour, on *Rheum nobile.*—P. M. Thomson, the flowering plants of New Zealand, and their relation to the insect fauna.—J. Sadler, on the flowering of *Yucca gloriosa.*—Prof. Dickson, on the septa across the ducts in *Bougainvillea glabra* and *Testudinaria elephantipes.*

Proceedings of the Linnean Society of New South Wales, vol. v., parts 1 and 2 (1880).—F. M. Bailey, medicinal plants of Queensland; on Queensland ferns, with descriptions of two new species; on a new species of Nepenthes.—M. A. Haswell, on some Queensland Polyzoa, plates 1 to 3; on some new Amphipods, plates 5 to 7.—Wm. Macleay, on a new species of Galaxias, with remarks on the distribution of the species; on a new species of Otolithus and of Synaptura.—Rev. E. T. Woods and F. M. Bailey, on the fungi of New South Wales and Queensland.—Rev. E. T. Woods, on the littoral marine fauna of North-East Australia; on a fossiliferous bed at the mouth of the Endeavour River; on the habits of some Australian Echini. —E. P. Ramsay, on a new species of Oligorus; note on *Galeo-*